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Video-rate quantitative phase analysis by a DIC microscope using a polarization camera: errata

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Abstract: We correct several errors in the derivation of the MTF shown in our original manuscript.

In our original manuscript, [1] Eqs (1) through (9) provided a derivation of the MTF for a partial-coherence measurement model of a DIC microscope. Our first error was a typo appearing in Eq. (6), where one of the terms is missing a factor of $\frac{1}{2}$. The correct Eq. (6) is:

$$o(x) = C\,\exp\{i\phi(x)\} \approx C\,\exp(i\phi_0)\left\{1 + i\phi(x) - \tfrac{1}{2}\phi^2(x)\right\}$$

Our second error was in assuming that the polarization matrices that we originally obtained from Ref. 2 were correct. On reflection, it is obvious that they cannot be. Ref. 2 gives the Jones matrices for a 45° linear polarizer as

$$\mathbf{P}(45^\circ) = \begin{pmatrix} \sqrt{2} & 0 \\ 0 & \sqrt{2} \end{pmatrix},$$

which represents an ND filter rather than a polarizer. A valid Jones matrix for a polarizer would instead be

$$\mathbf{P}(45^\circ) = \frac{1}{2}\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}.$$

Likewise, the matrices representing the retardances induced by the Nomarski prisms, $\mathbf{N}_1$ and $\mathbf{N}_2$, were given by Ishiwata *et al.* as

$$\mathbf{N}_1 = \begin{pmatrix} e^{i\pi(\xi\Delta+\theta)/2} & e^{-i\pi\xi\Delta/2} \\ 0 & 0 \end{pmatrix} \quad \text{and} \quad \mathbf{N}_2 = \begin{pmatrix} e^{-i\pi\xi\Delta/2} & e^{i\pi\xi\Delta/2} \\ 0 & 0 \end{pmatrix}.$$

These are not a valid retarder matrices, and should instead be

$$\mathbf{N}_1 = \begin{pmatrix} 1 & 0 \\ 0 & e^{i\pi(\xi\Delta+\theta)/2} \end{pmatrix} \quad \text{and} \quad \mathbf{N}_2 = \begin{pmatrix} 1 & 0 \\ 0 & e^{-i\pi\xi\Delta/2} \end{pmatrix}.$$

These when combined together form the matrix $\mathbf{A} = \mathbf{P}(\pm 45^\circ)\mathbf{N}_2\mathbf{N}_1\mathbf{P}(45^\circ)$ for the two analyzed polarization directions.

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When these revised forms for the polarization matrices are inserted into the equation for the transmission cross-coefficient R, we obtain

$$\mathbf{R}(f_x, f_x') = \int_{-\infty}^{\infty} \mathbf{A}\, p(\xi + f_x)\mathbf{A}^*\, p^*(\xi + f_x')\, \mathbf{Q}(\xi)\, d\xi\,,$$

so that $\mathbf{R}$ must take the form of a 2×1 vector rather than the scalar represented in Ref. 2 and our original manuscript. Thus, the illumination model $\mathbf{Q}(\xi)$ too must be expanded to take the form of a 2×1 polarization vector rather than a scalar. Finally, the equation representing the intensity distribution at the detector array, Eq. (1) in our original manuscript, should be calculated as the sum of squares of the two elements of the polarization vector. Since $\mathbf{A}$ has the simple form

$$\mathbf{A} = 2(1 + \cos\theta)\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix},$$

i.e. a scalar factor times the uniform matrix, all of these changes turn out to have no effect on the final result, Eqs (8) and (9) in the original manuscript. Indeed, the lack of effect on the result is how we missed the original error. Thus, the derivation was faulty but the result remains unchanged.

In addition, in the statement below Eq. (9), we stated that the background component (a) of Eq. (8) consists of $M(0)$ plus an integral that evaluates to a constant. Due to the presence of the variable x inside the integral, however, it does not evaluate to a constant but instead to a function of x.

The remainder of the paper, including the experimental results, is unaffected by each of these corrections.

Finally, in the acknowledgements, Dr. Ishiwata's first name was given incorrectly as Wataru, but should have been given as Hiroshi.

References

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